

Butterflies and Insecticides

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Many people believe that some indigenous species of British butterflies have become less common in recent years, although unfortunately, precise estimates of numbers are hard to come by. One of the most popular explanations for this alleged decline is the increased use of insecticides. I want, in this article, to examine the evidence for this explanation.

There are, of course, many possible reasons for any declines in the numbers of butterflies, but the idea that insecticides are responsible has several merits. The increase in the use of insecticides coincides roughly with the period during which the butterfly numbers are believed to have declined. There is also a considerable amount of circumstantial evidence that insecticides have decreased the numbers of some predatory birds in Great Britain. Furthermore, although it would be very difficult to make direct field tests, the credibility of the idea can be checked by toxicological tests on individual butterflies.

All of the most heavily used insecticides found in agriculture today belong to either the organochlorine or organophosphorus groups of compounds. These are all synthetic substances, and all of them have been developed during or since the Second World War. In general, the organochlorine insecticides are by far the more persistent group, both in the environment and within organisms, and so presumably they are the greater hazard to living animals. The half-life of organochlorines in soil can exceed ten years in extreme circumstances, but an average figure is three to five years.

I have tested the effects of two commonly used organochlorine insecticides, DDT and dieldrin, on *Aglais urticae*, the small tortoiseshell butterfly (Moriarty, 1968). Small drops of insecticide dissolved in a volatile solvent were placed on the surface of caterpillars during their last, fifth, instar. Some of the insecticide is absorbed through the cuticle, and most of this absorption occurs within 24 hours of dosing. The first step was to determine how much insecticide is needed to kill the caterpillars, and I found that dieldrin, for example, kills half of the caterpillars when the body concentration reaches from 0.5-5.0 parts of dieldrin per million parts of caterpillar. The higher concentrations occur in the heavier caterpillars.

However, death of individuals from insecticidal poisoning is not the only way in which populations of butterflies might be affected. Doses which are too small to kill could, in theory, affect populations in any of three ways. A sub-lethal amount of insecticide might alter the genetic constitution of future generations, or, within the individual, it might influence survival or reproductive ability.

In fact, there is no evidence for genetic effects on individual insects. The only way in which a population's gene pool can be affected is by selective kill of a proportion of the population. Death of a high proportion of individuals in successive generations from the use of insecticides has often produced a population which has a much greater resistance, and other linked characteristics may also change. But there is evidence for effects on survival and reproduction.

One of the more striking results with *A. urticae* is the effect of dieldrin on reproductive potential. In one experiment, a drop of solvent containing 1.25, 5 or 20 micrograms of dieldrin was put on the cuticle of a fifth instar larvae. Control larvae were dosed with solvent alone. Five male and five female adult survivors from each treatment were kept in a flight chamber until they died, and the number and fertility of all eggs laid were recorded (table 1). Only the controls laid many

TABLE 1.—The effect of dieldrin on the fertility and fecundity of *Aglaia urticae* (figures from Moriarty (1968)).

Dose of dieldrin applied to larvae (micrograms)	Number of egg clumps laid	Total number of eggs laid	Fertile eggs (%)
0	12	1,344	84
1.25	2	146	84
5.0	2	18	0
20.0	0	0	—

eggs, and the largest dose, which killed about half of the larvae, caused complete sterility of the surviving adults. Egg fecundity is affected by smaller doses than egg fertility. If effects such as this were to occur in the field, natural populations might well be devastated.

We need two items of information before we can decide how real such risks are. The first is, how much insecticide must be absorbed before any effects occur? It is generally supposed that any effect is the result of insecticide acting during some period of time after it has been absorbed on a specific 'site of action' within the insect's body. We know, for a given dose of dieldrin, how much is absorbed and remains within the body afterwards, but we cannot say how little is needed to cause sterility, because we do not know where or when the insecticide acts. However, dieldrin has a simpler effect on adult behaviour. Larvae dosed with 5 micrograms or more of dieldrin may produce adults which are markedly hyperactive, as though they were showing the initial symptoms of dieldrin poisoning. This response is presumably caused by the dieldrin present at that time, which is about 1.3 parts per million. This is the only absolute measure I know for insects of the minimum amount required for a sub-lethal effect.

The second item is, how much insecticide are insects likely to acquire? The amount present in a butterfly depends on the relative rates of several processes. First, of course, is the amount of insecticide absorbed by the insect, and the period of time during which it is absorbed. The degree of persistence depends then on how rapidly insecticide can be either excreted from the body or converted within the body to other compounds. Both dieldrin and DDT (in a modified form) are relatively persistent in *A. urticae*, and minute amounts of these compounds can be detected by recently developed methods of analysis. But a sample of twenty-two newly emerged first-brood adults taken in Huntingdonshire had no detectable organochlorine insecticides, although the limit of detection was less than 0.01 parts per million.

So we find that, as far as our knowledge extends, insecticide can produce sub-lethal effects in laboratory cultures of *A. urticae* after a single dose if the concentration within the body reaches about 1 part per million. But individuals in the field appear to contain less than

0.01 parts per million. If a straight comparison of these two figures is legitimate, there appears to be a safety factor of more than a hundred-fold. Of course, there are many possible criticisms of this conclusion. Individuals in the field may receive many small doses, which may be more deleterious than the same total quantity in one large dose. The harsher existence in the field may expose effects which do not appear in the laboratory. Other species may be more sensitive. But the available evidence, although scanty, does not suggest that insecticides have caused the alleged decline in the numbers of butterflies.

More information is needed. In particular, we need background information on the distribution and densities of various species, and their changes with time, so that any declines in numbers which may develop can be more quickly and surely detected. This knowledge would also make it much easier to find explanations and possible safeguards.

REFERENCE

- Moriarty, F. (1968). The toxicity and sublethal effects of *p,p'*-DDT and dieldrin to *Aglais urticae* (L.) (Lepidoptera : Nymphalidae) and *Chorthippus brunneus* (Thunberg) (Saltatoria : Acrididae). *Ann. appl. Biol.*, **62**, 371-393.

Portrait of Robert Dick

By I. R. P. HESLOP

At *Ent. Record*, **80**: 102, I contributed a note on the Robert Dick centenary Exhibition of 16th July, 1966, together with the complete text of my inaugural speech. In the note I mentioned the photograph of Robert Dick. This, as well as other relics, was discovered as a direct result of the interest aroused by the prodigious labours of Mr. Neil Campbell, Mr. Jack Saxon and Mr. John Bramman (whose names I gratefully record here in an entomological journal) in preparing the Exhibition.

This unique photograph, which dates from 1858, was turned up in Wick. With expert attention an excellent fresh negative was produced. It appears, however, that only two prints were made therefrom, and the picture has not been published. It is my anxiety lest this precious item should once again lapse into oblivion that has prompted me to have further prints prepared and to seek publication, for the very first time and after 111 years, of the one exact likeness of this great naturalist.

"Belfield," Burnham on Sea, Somerset. 20.viii.1969.

Letter to the Editor

August 19th, 1969.

Dear Mr. Editor,

I have wondered for some time whether you would consider making available a page or two of "The Record" for the increasing number of lepidopterists (in particular) who have added colour photography as an ancilliary, or indeed an absorbing primary pursuit in their study of insects. There is no question of turning The Record into a photographic journal, but a page given to a forum for the exchange of ideas on *modus operandi* would be of particular interest to many readers. Journals devoted to photography in general can afford only an occasional reference to such a specialized branch of camera work, such as this is. You must have among your readers, many who long to know more of how others achieve their results.